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THE HARCOURT INHALER.

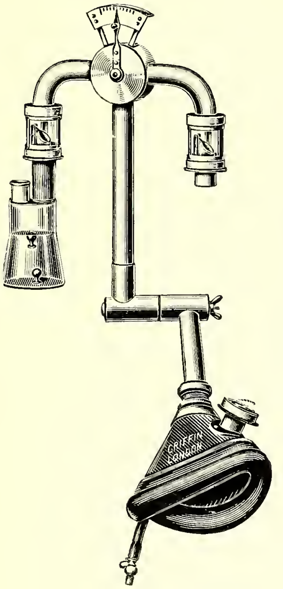
JOHN J. GRIFFIN & SONS, LTD.,
20-26, SARDINIA STREET, LINCOLN'S INN FIELDS, W.C.

A New Chloroform Inhaler,

[PATENTED]

In which the dose is indicated as a percentage mixture of chloroform with air.

(Invented by Mr. A. Vernon Harcourt, M.A., F.R.S.)



The Harcourt Chloroform Inhaler was first introduced to a special Chloroform Committee appointed by the British Medical Association to investigate the subject of anæsthesia in certain directions. One of the Committee, Dr. Dudley Buxton, at the instance of the other members of the Committee, tested the Inhaler clinically and reported in favourable terms of it. (*Supplement to the British Medical Journal, July* 18, 1903.) Mr. Walter Tyrrell also used the Inhaler, and his cases, which further demonstrated its value, appeared as an appendix to the Committee's Report. Since this pronouncement the apparatus has been in constant use at University College Hospital and in the hands of several anæsthetists, and has earned for itself the warmest approval.

From a clinical standpoint it is not too much to say that Mr. Vernon Harcourt's patient and truly scientific endeavour to produce an exact apparatus has been successful. It was somewhat doubtful, until extended use proved such to be the fact, whether a 2 per cent. vapour of chloroform was adequate for all cases. The common objection urged is that such a low tension vapour could only be applicable to subjects who were easily anæsthetised, but, when the apparatus is intelligently used, it is found to be sufficient in all cases.

The features most noticeable about the narcosis are that as the patient at first inspires a 0·2 per cent. vapour he is soothed and not excited ; if the increase in vapour strength be graduated with precision, the onset of narcosis is gradual, and what is more important, is even. There is no sudden variation. The onset travels as it were along an inclined plane ; there are no irregular elevations and depressions ; and as a result struggling whether voluntary or the result of over-strong vapour seldom occurs. The nerve storms and convulsive respiratory phenomena, at times met with among the alcoholic or muscular during the inhalation of Chloroform, seldom if ever occur when the low tension vapour is used, and hence the risks of the period of induction are lessened if not wholly removed.

After effects are certainly less when this Inhaler is used, and most patients express themselves as having found the method less painful than former experiences, in which other methods of giving Chloroform had been adopted.

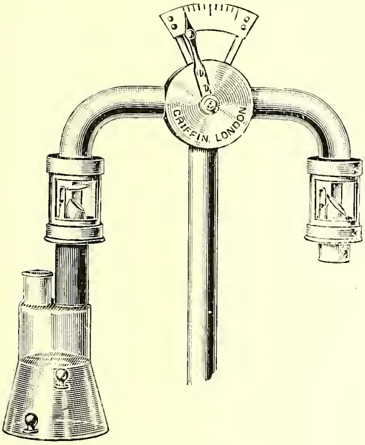
There can, we think, be no doubt that Mr. Vernon Harcourt's Inhaler is the best apparatus we possess and marks an enormous advance in our available methods. It would be premature to say more, but we confidently await the criticism of the next few years ; we believe it will more than justify what has been said, and will show that a low percentage vapour of Chloroform from an accurate Scientific apparatus such as Mr. Vernon Harcourt's, administered by an experienced anæsthetist, will give most satisfactory results.

When this method is universally adopted chloroform will once again take the premier place as the anæsthetic among anæsthetics, and its accidents will, if they arise at all, result from an unwise departure from known physiological principles.

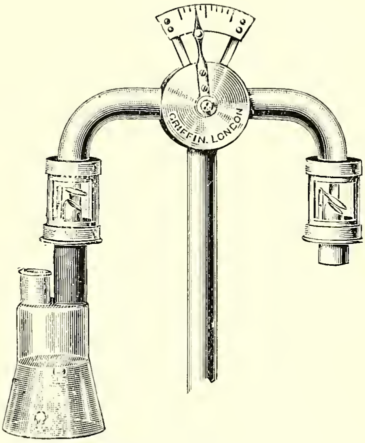
Description of the Apparatus.

The Harcourt Inhaler provides, in sufficient quantity for full and free respiration, a mixture of air and Chloroform which is automatically limited to a maximum strength of 2 per cent., and can be diluted at will with additional air down to any smaller proportion.

The two-necked bottle is filled with Chloroform to near the top of the conical part, and two coloured glass beads are dropped into the liquid to indicate when the temperature is within the range 13°—15°C. If the temperature of the Chloroform is below 13° both the coloured beads will float ; if it is above 15° both will sink ; in the former case the proportion of Chloroform inhaled will be less than the pointer of the stopcock indicates ; in the latter case it will be greater. The proportion is also increased by any agitation of the bottle. During inhalation the Chloroform is cooled by evaporation ; its temperature may be kept between 13° and 15° by now and then holding the bottle in the hand till the blue bead has sunk and the red bead is beginning to sink. The dimensions of the bottle have been arrived at after a great deal of experimental work and careful analysis. The diameter of the upper portion has been proportioned to the average rate of human respiration and to the rate of evaporation of chloroform between 13° and 15°C. To compensate for varying rates of respiration the inlet and outlet of the bottle are placed near together and at some distance from the surface of the liquid ; while to compensate for the lowering of the liquid surface by evaporation the vessel widens as the surface of the chloroform descends. The nearness of the two necks one to another, and the distance between them and the surface of the Chloroform, diminish the variation in the proportion of inhaled air to Chloroform vapour which is caused by abnormally shallow or deep breathing. When the flow of air is gentle much of it passes in at one neck and out at the other without reaching the surface of the Chloroform or displacing wholly the mixture of air and Chloroform which occupies the upper half of the bottle. On the other hand, the strong current caused by deep breathing drives out all the vapour which has been formed and promotes further evaporation by stirring the surface of the liquid. With bottles of the present dimensions this correction is only partial. If the rate of breathing is voluntarily reduced to 3 litres a minute instead of the normal 4 or 5 litres, or raised to 7 or 8 litres a minute, the proportion of Chloroform may be raised to about 2·5, or lowered to about 1·5 per cent. It would not be difficult by lengthening the cylindrical part of the bottle to correct more completely for variations in the rate of breathing. But it is believed to be advantageous that the proportion of Chloroform should vary thus, in order that there should be less variations in the total quantity of Chloroform administered. Two ratios have to be considered in judging of the probable effect upon a patient, that of Chloroform vapour to air, and that of the mass of Chloroform inhaled to the mass of the body through which it is distributed.



Pointer adjusted to give 2 per cent.

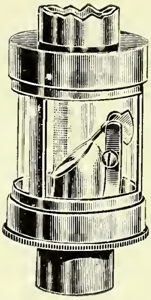


Pointer adjusted to give 1·4 per cent.

The stopcock is so made that when the pointer is at the end of the arc nearest the bottle of Chloroform the maximum quantity is being administered —namely, 2 per cent. When the pointer is at the opposite end only air will be inhaled; and when it is midway dilution of the 2 per cent. mixture with an equal volume of air will make the proportion 1 per cent. The shorter lines on either side indicate intermediate quantities—namely, 0·8, 0·6, 0·4, 0·2; and towards the Chloroform bottle, 1·2, 1·4, 1·6, 1·8.

The valves on the two branches prevent the entrance into the apparatus of expired air, and also serve to show whether the stopcock is working rightly. Only one valve opens when the pointer is at either end of the scale, both equally when the pointer is midway, and for all other positions one valve opens more and the other less, in the degree indicated by the position of the pointer on the scale. The movement of these valves shows also how full and regular the breathing is, and the slight click which they make conveys this information to the ears when the eyes are otherwise occupied.

It is generally found that beginning with the pointer at 0·2 and moving it on towards the Chloroform bottle at the rate of one division about every half-minute up to 1·6 or 1·8 produces narcosis as quickly as is desirable.



For the maintenance of narcosis it is believed that 1 per cent. or even less will be found sufficient. The stopcock can be moved by a touch of the finger so as at once to increase or diminish the dose.

If by fall of temperature or agitation of the bottle the yield of Chloroform is diminished or increased this may be allowed for at once by a movement of the stopcock.

The face-piece, which is provided with an expiratory valve, and can be fixed in any position, is either attached directly to the inhaler, which in this case is held in the hand, and should be kept as nearly vertical and as steady as possible, or can be connected by about 20 inches of half-inch rubber tubing ; the inhaler in this case being supported on a stand or hung on to the back of the bed.

The mask is made of solid toughened rubber, fitted with a rubber air-cushion. It can be washed, or boiled, and as it becomes plastic in hot water the shape can easily be modified, if required, so as better to fit the patient's face.

Certain cases may occur in which a stronger dose is required than that afforded by the apparatus as above described. For increasing the strength of the vapour inhaled a small tube is provided which fits into the open neck of the bottle raising the possible maximum dose to 2·5 or 3 per cent. To obtain a 2·5 per cent. mixture the larger end of the tube, marked 2·5, must be inserted in the bottle, and for 3 per cent. the smaller end, while the pointer is kept at the end of the scale nearest the Chloroform. At intermediate positions of the pointer the dose will be increased in the same proportion as the maximum.

No Chloroform evaporates excepting that which is inhaled by the patient ; and only that which is exhaled passes into the air of the room. *A great economy of Chloroform is thus effected, which should in a short time repay the cost of the apparatus to Institutions or medical men in large practice by whom it may be used.*

ON THE USE OF THE HARCOURT INHALER.

The apparatus must be carefully examined to see the parts are adjusted, and the administrator should inhale or incline the instrument sideways to see that the valves are working properly. About 1½ oz. of Chloroform should be poured into the conical bottle and the beads introduced. The face mask should then be carefully applied. This is best done when the head is turned to one side. Breathing taking place freely and the air inlet valve and expiry valve flapping properly the inhaler should be grasped at the horizontal cross-piece with the right hand, while the lower jaw is pressed forward by the left hand placed behind the angle of the mandible. Firm pressure is necessary, as absolute co-adaptation of the mask to the patient's face is essential. If the pressure used is equal over the whole area of the face the patient will not complain. It is a common fault to allow air to enter by the sides of the bridge of the nose. Absolute fitting of the face-piece having been secured, the strength of the vapour may be gradually increased by turning the pointer. This is done slowly, but unless the patient is restless and struggles, not too slowly. Struggling is an indication for the lessening of the strength of the vapour but not for removal of the face-piece unless duskiness supervenes. When narcosis is attained, the usual signs being relied upon, in most cases the maintaining of anæsthesia can be effected with 1·5, 1 or even ·5 per cent. according to the physique of the patient and the requirements of the operation. After prolonged administration slight duskiness may appear, and in this case the apparatus may be lifted for a few breaths and then replaced.

By the kind permission of the Editor of the "British Medical Journal" we are enabled to append an extract from the issue above cited, giving an account of some cases in which Mr. Vernon Harcourt's Apparatus was used prior to the Report of the Chloroform Committee in July, 1903. *Some additional cases are given on pp.* 16, 17.

EXTRACT FROM REPORT OF CASES OF NARCOSIS IN WHICH MR. VERNON HARCOURT'S APPARATUS WAS EMPLOYED AT UNIVERSITY COLLEGE HOSPITAL.

By Dudley W. Buxton, M.D., B.S., M.R.C.P.,
Anæsthetist to University College Hospital.

A. Woman, aged 50. Exploratory trephining, Patient alcoholic, and induction prolonged and narcosis light (talking); 2 per cent. required for induction, 1 per cent. used during operation.

Male, aged 15, removal of testicle. Induction ·5 to 1 per cent., six minutes, Quiet narcosis maintained with ·5 per cent.

Male, 19, for genu valgum. Induction ·5 to 1 per cent. in six minutes, maintained at ·5 mostly.

Elderly male, Kraske's operation. Induction ·5 to 1 per cent. for six minutes, then 2 per cent. Patient lying on his chest, anæsthesia maintained 1 per cent. with occasionally 1·5 per cent. and 2 per cent., but owing to posture some leakage was probable around mask.

Powerful man, resection of cervical nerves for Torticollis; 1 per cent. used.

Woman, aged 50, removal of breast; 1 per cent. used.

In these and other operations, Mr. Crawford (House Physician) remarks the period of induction was usually devoid of struggling. The patients took the anæsthetic easily. The degree of narcosis was light ; no dangerous symptoms arose.

B. Female, 31, femoral hernia. Induction ·5 to 2 per cent. in 7½ minutes. No struggling. Operation performed with 1 per cent. ; Patient quiet, but C. R. present—duration forty-five minutes. 4 fl drachms used.

W. B., male, 19, for cerebral tumour. Induction 1·5 per cent. in 2 minutes, C. R. present. Operation done in thirty minutes under ·5 per cent. No struggling. 1½ fl drachms used.

Female, 46, removal of kidney. Induction eight minutes, ·5 to 2 per cent. Slight struggling. No movement during operation, although, owing to posture, some air probably entered round mask, reducing percentage below 2. C. R. present, although sluggish. Duration of narcosis eighty minutes. 1 fl oz. used.

In all these cases respiration was accelerated at times during operations, when dragging or other peripheral stimulation was practised owing to anæsthesia being light.

Male, 32, for cerebral tumour. Induction ·5 to 2 per cent., ten minutes ; was restless 15 minutes. During operation 2 per cent., 1 per cent., then ·5 per cent. Final sewing up caused movement, 2 per cent. given. Duration, forty minutes. ½ fl oz. used. Patient gained consciousness in five minutes after cessation of inhalation.

Female, 29, fissure and ulcerated pile. Induction, ·5 to 2 per cent., ten minutes. Dilation of sphincter caused quickened breathing. C. R. sluggish during operation. Duration, thirty-six minutes. Regained consciousness in about half an hour. Some sickness during the night.

Male, 24, radical cure of hernia. Induction, ·5 to 2 per cent., seven minutes ; no struggling. Slight movement of limbs after skin incision, and quickening of respiration upon dragging on deep structures. After twenty-five minutes, as some duskiness was present, 1·5 per cent. used ; cyanosis lessened. In thirty-two minutes 1 per cent. used, but coughing and finally vomiting occurred, so 2 per cent. was gone back to after three minutes. Final skin sutures quickened respiration. Recovered consciousness five minutes after discontinuance of anæsthetic and vomited. Duration, fifty minutes.

The cases cited were mostly done in my presence by my dressers, so, the apparatus was subjected to a more severe test than if it had been in the hands of an expert. The most noticeable points about the narcosis which was induced are : (*a*) the facility with which patients inhale ; (*b*) the slight amount of excitement or struggling ; (*c*) its light degree and the readiness with which it lightens ; (*d*) the rapid recovery ; (*e*) absence of anomalous symptoms.

EXTRACT FROM REPORT ON THE USE OF MR. HARCOURT'S INHALER.

By Walter Tyrrell, Anæsthetist to St. Thomas' Hospital.

Mr. Tyrrell has been impressed with the value of the principle of this method but believes that the details of mechanism may be improved.* In using the method he admits having tried to see how small a percentage would suffice. He has been most careful in fitting the face-piece well. He has not yet met with a case requiring 2 per cent. or more, but believes such cases will be met with. He has been much struck with the marked absence of excitement when this method was used and increasing gradually the percentage.

M. M., æt. 49, female.—Iridectomy for Glaucoma. Commenced—

2.12 P.M.	0·2 per cent.
2.13 ,, ...	0·5 ,,
2·14 ,, ...	1·0 ,,
2.17 ,, ...	Muttering.
2.18 ,, ...	Irrigating eye.
2.21 ,, ...	Complete anæsthesia.
2.26 ,, ...	Operation concluded. Very satisfactory anæsthesia. 1 per cent. not exceeded.

E. C. F., æt. 41, female.—Puncturing frontal sinus. Commenced—

3.26 P.M.	0·2 per cent.
3.26½ ,, ...	0·4 ,,
3.27 ,, ...	0·6 ,,
3.27½ ,, ...	0·8 ,,
3.28 ,, ...	1·0 ,,
3·34 ,, ...	1·4 ,,
3·40 ,, ...	Complete anæsthesia.
3·50 ,, ...	Operation concluded. Patient much better colour than before commencement of operation.

G. B., æt. 20, male.—Varicose veins. Commenced—

3.10 P.M.	0·2 per cent.
3.11 ,, ...	0·5 ,,
3.12 ,, ...	1 ,,
3·15 ,, ...	1·5 ,,
3.18 ,, ...	Stertorous breathing.
3.20 ,, ...	Conjunctival reflex gone ; there has been absolutely no excitement or movement of any kind ; scrubbing of legs going on.
3·30 ,, ...	Incision which made breathing rather deeper.
3·33 ,, ...	1 per cent., as the deeper respiration rather dilated the pupils.
3·36 ,, ...	1·3 per cent., as pupils contracted and slight corneal reflex returned.
3·40 ,, ...	Pupils contracted ; deep, slow, stertorous breathing ; no ocular reflex.

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* Since this report was published the apparatus has been improved in several important respects.

4.19 P.M.	Replenished $CHCl_3$, turned indicator to 0·5 per cent. for two or three respirations, and then to 1 per cent.
4.25 ,,	Ceased administration.

C. P., æt. 63, female.—Subcoracoid dislocation. Big fat woman, cannot breathe comfortably without several pillows. Mitral and aortic disease. Stethoscope leaves marks on chest. Very feeble pulse. Commenced—

2.22 P.M.	0·5 per cent. Strychinine gr. $\frac{1}{10}$.
2.24 ,,	1·0 ,,
2.30 ,,	Some slight excitement.
2.34 ,,	Light anæsthesia. Complete muscular relaxation. Dislocation easily reduced.

G. W. G., æt. 19, male.—Appendicotomy. Commenced—

2.19 P.M.	0·2 per cent.
2.20 ,,	0·5 ,,
2.21 ,,	1·0 ,,
2.25 ,,	1·5 ,,
2.26 ,,	Excitement.
2.27 ,,	Stertor. Corneal reflex gone.
2.28 ,,	1 per cent., which was steadily maintained until—
3.30 ,,	Operation concluded.

J. C., æt. 32, male. Hernia. Commenced—

3 P.M.	0·5 per cent.
3.2 ,,	0·8 ,,
3.3 ,,	1 ,,
3.11 ,,	Conjunctivæ insensitive, pupils contracted ; there has been no stage of excitement.
3.12 ,,	Incision made—slight reflex movement of leg on operated side during skin incision.
3.15 ,,	Pupils dilating—put back to 0·6 per cent., but had to replace at once to 1 per cent.
3.23 ,,	Pupils well contracted, regular stertorous breathing ; lessened to 0·6 per cent., but at
3.25 ,,	Pupils dilating, and had to replace at 1 per cent.
3.30 ,,	Anæsthetic stopped.